CALLOTAXIS IN CHILDREN: CONGENITAL VERSUS ACQUIRED LIMB LENGTH DISCREPANCY

+++Antoci, V; *Ono, CM; **Antoci Jr, V; *Raney, EM
++Shriners Hospitals for Children, Honolulu, HI, USA; **Jefferson University, Philadelphia, PA, USA.
E-mail: viantoci@hotmail.com

Callotaxis introduced by Professor Ilizarov established that limbs can be regenerated by gradual tension force (1). Few reports have compared patients who had congenital vs. acquired shortening (2). In this study we evaluated and compared the results of limb lengthening in congenital vs. acquired leg length discrepancy (LLD).

MATERIALS AND METHODS
The lengthening index, calculated as the number of days of external fixation treatment per centimeters of new-formed bone regenerate length; the lengthening percentage, calculated as the distraction regenerate length divided by the pre-lengthening bone segment length multiplied by 100; the length of distraction regenerate (cm), the patient’s age, the bone segment involved (femur, tibia), deformity (1, 2, and 3-dimensional), osteotomy type (subperiosteal corticotomy, osteotomy with multiple drill holes and an osteotome, osteotomy with an oscillating saw, and osteotomy with Gigli saw), level of distraction (diaphysis, metaphysis, bifocal), treatment periods (latency, distraction, consolidation), the rate of distraction, the need for additional surgical interventions; and the complication rate were used to evaluate and compare the results of limb lengthening in congenital vs. acquired leg length discrepancy of a total of 116 lower limb lengthening in 88 consecutive patients treated between 1990 through 2003 for congenital (31 patient with 46 lengthened segments) and acquired (57 patient with 70 lengthened segments) LLD. T-Tests: Two-Sample Assuming Unequal Variances and ANOVA followed by post-hoc t-tests with an alpha level of p=0.05 was applied to compare the difference between acquired and congenital LLD.

RESULTS
The patient’s age ranged from 4 to 20 years (mean 13.5 years) in acquired LLD, and from 4 to 19 years (mean 13.5 years) in congenital group. There were 34 tibial and 36 femoral lengthenings in acquired LLD, and 28 tibial and 18 femoral lengthenings in congenital LLD. Most of lengthening in both groups was done by subperiosteal corticotomy: (acquired 74.7%, congenital 71.1%). There was also used osteotomy with multiple drill holes and an osteotome: 17 bones (14.7%), osteotomy with an oscillating saw: 10 bones (8.6%), and osteotomy with Gigli saw: 4 bones (3.4%). There was also used osteotomy with multiple drill holes and an osteotome: (acquired 14.9%, congenital 13.9%), osteotomy with an oscillating saw: (acquired 8.1%, congenital 8.9%), and osteotomy with Gigli saw: (acquired 2.3%, congenital 6.1%).

There were 50 metaphyseal (43%): acquired 32 (45.7%), congenital 18 (39.1%); 50 diaphyseal (43%): acquired 32 (45.7%), congenital 18 (39.1%); and 16 bifocal (14%): acquired 6 (8.6%), congenital 10 (21.7%) lengthenings. There was lengthening alone in about half of cases (57 bones, 49.1%), 2-dimensional deformity correction – 5 bones (10.9%), distraction of the bone began on average 5.7 days after the osteotomy. The rate of distruction was 1 mm per day, correction – 5 bones (10.9%). Distraction of the bone began on average 5.7 days after the osteotomy. The rate of distruction was 1 mm per day, correction – 5 bones (10.9%).

Acquired LLD patients underwent pure lengthening - 24 bones (52.2%), 2-dimensional deformity correction – 24 bones (52.2%), and 3-dimensional deformity correction – 13 bones (26.6%). Congenital LLD patients underwent pure lengthening - 24 bones (52.2%), 2-dimensional deformity correction – 17 bones (36.9%), and 3-dimensional deformity correction – 5 bones (10.9%). Distraction of the bone began on average 5.7 days after the osteotomy. The rate of distraction was 1 mm per day, divided into four 0.25-mm equal increments. The distraction rate was decreased if there was radiographic evidence of poor bone formation or if the patient complained of excessive pain. Conversely, the rate was increased if radiographs showed accelerated consolidation of the regenerate. After fixator removal, most limbs were further protected for 4 to 6 weeks in an external orthosis or cast. The lengthening indexes in congenital (34±2.4 days/cm) and acquired (32±1.0 days/cm) LLD were not significantly different (P>0.05). There was no significant difference (P>0.05) when comparing separately congenital short tibia (37±3.2 days/cm) vs. acquired short tibia (32±1.6 days/cm), or congenital short femur (29±3.2 days/cm) vs. acquired short femur (32±4.4 days/cm). The length of distraction regenerate: congenital (6.49±0.5 cm) and acquired (5.7±0.3 cm) were not significantly different (P>0.05). The lengthening percentage in congenital LLD (252.0) was significantly higher (P<0.05) than in acquired conditions (19±1.8). There was a significant difference between metaphyseal (27±1.2 days/cm) and diaphyseal (39±1.7 days/cm) lengthening (P<0.05). The lengthening index was not influenced by the deformity complexity. There was no significant difference among the lengthening indexes when treating 1, 2, or 3-dimensional deformities in both congenital and acquired LLD. During lengthening of congenital LLD there was an increase in complications rate: neurologic (35.5% vs. 28.1 in acquired), broken pins (22.6% vs. 15.8 in acquired), joint contractures (29% vs. 14 in acquired), and hypertension (16.1% vs. 12.3 in acquired). Also there was an increase in post lengthening residual axial deformity (32.3% vs. 26.3 in acquired) and peroneus neuropaxia (6.5% vs. 0 in acquired). In acquired LLD there was 5.3% of post lengthening residual chronic osteomyelitis vs. none in congenital. There was almost equal number of additional surgeries per patient (1.4) and per lengthened segment (1) in both congenital and acquired LLD lengthening.

DISCUSSION
Correction of LLD is reliably achieved by distraction osteogenesis. Dahl et al. (3) stated that complication rate occurred twice as often in lower extremity lengthening greater than 15%. Maffulli et al. (2) concluded that a significantly greater number of difficulties were found in patients whose lengthening exceeded 18% of the original length of bone. Maffulli et al. (4) and Karger et al. (5) concluded that to limit the complication rate to an acceptable level, the amount of lengthening should probably not exceed 25% of the initial bone length. The prevalence of complications seems to be correlated to the complexity and the duration of treatment. Our results showed that during lengthening of congenital LLD there was an increase in complications rate. The lengthening percentage in congenital LLD (25±2.6) was significantly higher than in acquired conditions (19±1.8), which correlates very well with the increase in complication rate. A detailed analysis of complications provided evidence that the number of complications increases as the lengthening percentage increases. Our results revealed that limb lengthening is a very complex process with numerous pitfalls, which equally correlated with lengthening percentage in both groups: congenital and acquired LLD. The outcomes of present study suggest that the use of lengthening index to estimate the final result of distraction osteogenesis is problematic. The lengthening index depends on the amount of length gained and the lengthening percentage. The lengthening index could not be used to predict the complication rate; it depends on the complication rate. The lengthening percentage correlates better with complication rate and can be used to predict the complication rate. The distraction osteogenesis is capable to achieve remarkable increase in the bone length, however the price is increased treatment time and complications rate. Bone is equally produced regardless of etiology: acquired or congenital. The lengthening index is helpful to estimate approximate duration of treatment necessary for each planned lengthening and the lengthening percentage is useful to predict the complication rate.

REFERENCES